

UPPER PERMIAN INSECTS OF NEW SOUTH WALES.

PART I. INTRODUCTION AND THE ORDER HEMIPTERA.

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(Plate i and Twenty-seven Text-figures.)

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The honour of discovering the first Palaeozoic fossil insect wing in New South Wales belongs to Mr. John Mitchell, late Head of the Technical College, Newcastle, N.S.W. The announcement of this discovery was made in a short note communicated to these Proceedings, xxiii, 1898, p. 437. This fossil wing was unfortunately lost before it was scientifically studied; but, from Mr. Mitchell's account of it, given to me personally, I think there can be little doubt that it belonged either to the Mecoptera or the Paramecoptera. It was discovered in the shale overlying the Yard Seam at the base of the Flagstaff Hill, Newcastle, a horizon which has been calculated to lie about 800 feet vertically below the top of the Palaeozoic rocks in New South Wales (Wallarah or Bulli Coal Seam).

Mr. Mitchell has very carefully explored this horizon for many years, but has only succeeded in finding one or two further wings at or about the same horizon at Newcastle. In the meantime, however, he discovered the Belmont fossil insect beds, in a shallow quarry of hard chert about two miles from Belmont on Lake Macquarie. These beds have been worked for some years both by Mr. Mitchell and later by Mr. and Mrs. T. H. Pincombe, of New Lambton, and a large number of fossil insects have been discovered there. The Belmont horizon* is some 500 feet vertically above the previously mentioned insect-bearing strata at Newcastle, i.e. about 300 feet below the top of the Palaeozoic rocks of New South Wales.

Mr. Mitchell also discovered two wings, described by me in 1922, from burnt shale forming part of the embankment of the Burwood Colliery railway at Merewether Beach, near Newcastle. The exact horizon of these wings is doubtful, but they are either from about the same horizon as that of the original wing discovered at Newcastle, or else from the Burwood Coal Seam, a hundred feet or more vertically above that.

More recently Mr. Mitchell and Mr. Pincombe have been exploring the rocks at Warner's Bay, which are also probably about the same horizon as that of the Belmont Insects, and have succeeded in finding a fair number of insect remains, mostly in a very dark coloured chert. These fossils will be dealt with in this paper, together with a number of the later discoveries from Belmont.

* Mr. Mitchell originally estimated these beds to be some 600 feet below the top of the Palaeozoic strata, but has quite recently sent me the revised estimate here given.

The faunas disclosed by the above discoveries are all so closely similar that I propose for the present at any rate to consider them as a single whole, which I shall designate as the Upper Permian Insect Fauna of the Newcastle Coal Measures. The number of fossils now known is at any rate large enough to give us a very clear idea of this insect fauna and to enable us to draw some very interesting deductions therefrom.

The two most remarkable things about this fauna are, firstly, its high specialization, which in spite of its being an Australian fauna, is far in advance of that of any other known Palaeozoic insect fauna, and secondly, its restriction to very few Orders. The Orders represented are the Hemiptera (Suborder Homoptera only), Mecoptera, Neuroptera and Coleoptera, together with two extinct Orders not represented elsewhere, viz. the Paramecoptera and the Protocoleoptera, the former being ancestral to the Diptera, Trichoptera and Lepidoptera, the latter to the Coleoptera. The dominant Order is the Hemiptera, which, it should be noted, are also the only undoubted Hemimetabolous insects to be found in these beds; all the rest are either Holometabolous or direct ancestors of known Holometabola (Protocoleoptera) which were also, most probably, Holometabolous themselves. There are practically no large wings present, and the general average size is very small indeed. Groups usually associated with a forest flora, such as the Cockroaches (Blattoidea), or typical of a warm, subtropical climate, are entirely absent. It would, perhaps, be rash to assert positively that such typically aquatic insects as Dragonflies, Mayflies and Stoneflies did not exist there, or even that no Orthopteroid forms occurred, but the fact remains that none have so far been discovered, and the most recent consignments received from the collectors do not extend the list of Orders in any direction, though new families and genera continue to be added.

If the association of Insects represented in this fauna, with its dominance of Homoptera and Coleoptera and its abundant remains of Mecoptera, were to be presented to a specialist in fossil insects, without any evidence of its correct horizon, he would be almost bound, on the evidence, to consider it as a Triassic fauna and would probably reject straight away any suggestion that it might have come from a Palaeozoic horizon. In composition, it comes very much closer to the well-known Upper Triassic fauna of Ipswich, Queensland (though lacking many of the Orders found in these latter beds) than it does to the very large and well-known Lower Permian fauna of Kansas, where Coleoptera and Neuroptera were entirely unknown, and only four very primitive Homoptera have so far been found out of a total of about 2,000 specimens. The restricted range and high specialization of the Upper Permian fauna may be partially explained by assuming that the climate was colder than that of the Ipswich Upper Triassic; whether this was actually so or not can only be determined by a study of the associated flora.

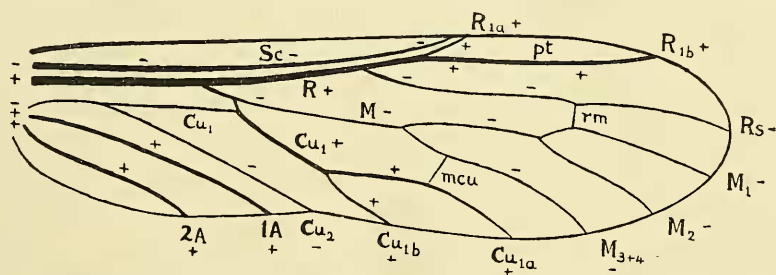
A number of fossils from these Upper Permian beds have already been described by me in scattered papers. Instead of going on with similar descriptions dealing with each collection as it comes to hand, it seems to me that it would be better to make a complete survey of the material now to hand. For this purpose, therefore, I have planned a short series of three papers, the first dealing with the Hemiptera, the second with the Mecoptera, Paramecoptera and Neuroptera, and the third with the Coleoptera and Protocoleoptera. Genera already defined and species already described from these beds will be included in the keys here given, so that each Part will offer a complete survey of the Upper Permian fauna for the Order or Orders dealt with. In the figures, the apex of the wing is always placed

to the right, to facilitate comparisons. The photographs from which Plate i has been prepared were taken by Mr. W. C. Davies, Curator of the Cawthron Institute, to whom my best thanks are due.

Order Hemiptera.

Suborder Homoptera.

The Hemiptera is the only Hemimetabolous Order of insects so far discovered in these beds, and is the dominant Order both as regards the number of specimens found and the number of genera and species actually represented by them. All the fossils can be definitely classed as Homoptera and have already attained a considerable degree of specialization within that Suborder. In order to understand this position, I have figured for contrast (Text-fig. 1) the tegmen of one of the four most primitive of all known Homoptera, from the Lower Permian of Kansas,



Text-fig. 1. *Permoscytina kansasensis* Till., family Permoscytinidae, Lower Permian of Kansas, U.S.A. Tegmen. 1A, 2A, the two anal veins; Cu₁, first cubitus, with its branches Cu_{1a}, Cu_{1b}; Cu₂, second cubitus or vena *dividens*, separating clavus from rest of tegmen; M, media; M₁, M₂, M₃₊₄, its three branches; m_{cu}, medio-cubital cross-vein; pt, pterostigmatic area; R, radius; R₁, its main stem, with branches R_{1a}, R_{1b}; Rs, radial sector; rm, radio-median cross-vein; Sc, subcosta. The sign + indicates a convex, — a concave, vein.

viz. *Permoscytina kansasensis* Till. (1925). Three of the four known Lower Permian Homoptera are primitive Auchenorrhyncha of this type, having an elongated, tough tegmen with a complete but simple venation of a very definite type; the fourth is a much smaller tegmen belonging to the Sternorrhyncha, much broader and more rounded in form, with the same type of venation exactly, except that the clavus or anal area is reduced and the anal veins are absent. These primitive types resemble the primitive Copeognathous forewings from the same horizon in their general scheme of venation, particularly in the form of the pterostigmatic area (pt), which is an elongated area closed by R_{1a} basally and by the much longer R_{1b} posteriorly, and in the form of the first cubitus, Cu₁, which is distally forked in both Orders. In these wings, R₁ is an excessively strong, convex vein, while Rs, as in all other Palaeozoic Orders, is a concave vein. Consequently, when we find the pterostigmatic area bounded posteriorly by a strongly convex continuation of R₁, we recognize at once in this formation the homologue of the pterostigma in Mecoptera and Copeognatha, and understand that the vein marked R_{1b} is in reality the original distal portion of vein R₁, while the short piece marked R_{1a} is a branch developed to bound the pterostigmatic region basally. Comstock considered (from a study of recent Homoptera only) that the short vein R_{1a} was the true R₁, and named the vein here called R_{1b} as R₂₊₃, i.e. part of the radial

sector, in spite of the fact that it arises separately from the main stem of R. These ancient fossils undoubtedly show us the true state of the case, and an alteration of Comstock's notation in this Order is therefore necessary.

These primitive Homoptera also agree with primitive Copeognatha in the form of their clavus or anal area, which is short, bounded above by a straight *vena dividens* (Cu_2) in the form of a deep groove or concave vein, and carries two very strongly marked *convex* anal veins, 1A and 2A. The slightly excavated form of the posterior margin at the end of Cu_2 is also typical, the clavus ending distally in a sharp angle. Also it is characteristic of these wings that, when fossilized, the clavus does not separate from the rest of the wing along the *vena dividens*, but remains fully attached to it.

The simple, unbranched Rs and the three-branched M are characteristic of the most primitive members of the Homoptera, and mark them off sharply from the most primitive Copeognatha, in which Rs is forked and M four-branched. Only two cross-veins are present, viz. *rm* and *mcu*, at or near the positions shown in Text-fig. 1.

When we contrast Upper Permian and all later representatives of the Homoptera with these primitive types, we meet with a very interesting fact in the evolution of the Auchenorrhyncha. The clavus becomes lengthened, so that Cu_2 ends well beyond half-way along the posterior margin of the wing, and the *vena dividens* becomes so deeply impressed in the wing membrane that, under the usual conditions of fossilization, the tegmen splits along it, separating the clavus from the rest of the wing and giving two separate fossils. With few exceptions, we find, both in the Upper Permian and Upper Triassic beds, either the tegmen fossilized without the clavus, or else the clavus by itself. Even in the case of some of the Upper Permian Sternorrhyncha, in which the clavus is greatly narrowed and the anal veins are generally absent, we sometimes find the clavus absent and the tegmen bounded, in the fossil, by Cu_2 .

Compared with the Lower Permian forms, the Upper Permian Auchenorrhynchous Homoptera show a number of other tendencies towards specialization; the subcosta is very seldom present; pterostigmatic veinlets may be developed; further distal branching of M or of Cu_1 may take place, and the main stem of Cu_1 may become very curved; the costa tends to become greatly arched and the costal space very wide. All these tendencies are again met with in the Upper Triassic fauna, but the number of highly specialized forms is considerably greater.

Nearly all the impressions found are those of tegmina or forewings, but at least one complete body has been found and two complete hindwings. The latter are of a much more primitive type than those of recent Auchenorrhyncha and possess neither a strongly developed and folded anal area nor an ambient vein.

The following is a complete list of the known genera and species of Homoptera from the Upper Permian of Australia:

Division Auchenorrhyncha.

Family Scytinopteridae.

Genus 1. PERMOJASSUS, n.g.

1. *Permojassus australis*, n. sp. Genotype. Warner's Bay.
2. *Permojassus dubius*, n. sp. Belmont.

Genus 2. ORTHOSCYTINA, n.g.

3. *Orthoscytina mitchelli*, n. sp. Genotype. Belmont.
4. *Orthoscytina quinquimedia*, n. sp. Warner's Bay.
5. *Orthoscytina indistincta*, n. sp. Belmont.
6. *Orthoscytina subcostalis*, n. sp. Belmont.

- Genus 2. **ORTHOSCYTINA**, n.g. (*Continued*).
 7. *Orthoscytina irregularis*, n. sp. Belmont.
 8. *Orthoscytina belmontensis*, n. sp. Belmont.
 9. *Orthoscytina obliqua*, n. sp. Belmont.
 10. *Orthoscytina pincombei*, n. sp. Belmont.
 11. *Orthoscytina tetraneura*, n. sp. Belmont.
- Genus 3. **STENOSCYTINA**, n.g.
 12. *Stenoscytina australiensis*, n. sp. Genotype. Belmont.
- Genus 4. **HOMALOSCYTINA**, n.g.
 13. *Homaloscytina plana*, n. sp. Genotype. Warner's Bay.
- Genus 5. **ELLIPTOSCARTA**, n.g.
 14. *Elliptoscarta ovalis*, n. sp. Genotype. Belmont.
- Genus 6. **ACTINOSCYTINA**, n.g.
 15. *Actinoscytina belmontensis*, n. sp. Genotype. Belmont.
- Genus 7. **PERMOSCARTA** Till., 1918, p. 726.
 16. *Permoscarta mitchelli* Till. Genotype. Newcastle.
 17. *Permoscarta trivenulata*, n. sp. Warner's Bay.

Family **Prosolididae**.

- Genus 8. **PERMOGLYPHIS**, n.g.
 18. *Permoglyphis belmontensis*, n. sp. Genotype. Belmont.
- Genus 9. **PERMODIPHATHERA**, n.g.
 19. *Permodiphthera robusta*, n. sp. Genotype. Belmont.
 20. (?) *Permodiphthera dubia*, n. sp. Belmont.
- Genus 10. **MITCHELLONEURA** Till., 1922a, p. 414.
 21. *Mitchelloneura permiana* Till. Genotype. Merewether Beach.

Division **Sternorrhyncha**.

Family **Pincombeidae**.

- Genus 11. **PINCOMBEA** Till., 1922b, p. 282.
 22. *Pincombea mirabilis* Till. Genotype. Belmont.

Family **Permopsyllidae**.

- Genus 12. **PROTOPSYLLIDIUM**, n.g.
 23. *Protopsyllidium australe*, n. sp. Genotype. Warner's Bay.
- Genus 13. **PERMOPSYLLIDIUM**, n.g.
 24. *Permopsyllidium mitchelli*, n. sp. Genotype. Belmont.
 25. *Permopsyllidium affine*, n. sp. Belmont.
- Genus 14. **PERMOTHEA**, n.g.
 26. *Permothea latipennis*, n. sp. Genotype. Warner's Bay.

Family **Lophioneuridae**.

- Genus 15. **LOPHIONEURA** Till., 1922a, p. 417.
 27. *Lophioneura ustulata* Till. Genotype. Merewether Beach.
 28. (?) *Lophioneura conjuncta*, n. sp. Belmont.

The Upper Permian fossil Homoptera may be classified as follows:

- Small to large wings (5 mm. up to 25 mm.) with a broad, well-developed clavus carrying two strong, convex anal veins Division **AUCHENORRHYNCHA**
 Very small wings (less than 6 mm. long) with reduced, narrow clavus, the anal veins usually absent, rarely one or both present Division **STERNORRHYNCHA**

Division **Auchenorrhyncha**.

Most of the Upper Permian fossil tegmina in this division are closely allied to the species *Scytinoptera kokeni* Handl., from the Upper Permian of Russia. They are characterized by the strongly arched costa and wide costal space, by the unbranched Rs, by the long, straight and deeply concave Cu₂ ending far beyond half-way along the posterior margin, and by the widely separated anal veins. These are all placed in the family Scytinopteridae, which may be considered as directly ancestral to the present-day Cercopidae and Jassidae. In all of them the membrane of the tegmen shows no sign of division into a tougher basal and a softer distal portion. There are, however, three tegmina present in which such a



division is to a certain extent present, and in which the venation agrees rather with that of *Prosbolia hirsuta* Handl., also from the Upper Permian of Russia, particularly in having Rs distally branched. These, together with a large hindwing evidently belonging to the same type, are here placed in a separate family Prosbolidae, which is almost certainly directly ancestral to the present-day Tropicuchidae, and also, perhaps, to other families of Fulgoroidea. Mr. F. Muir considers that these fossils are true Tropicuchidae, but the primitive character of the hindwing is probably sufficient to make it advisable to keep the two families distinct. Elsewhere (1922, p. 461) I placed the related genus *Mesodiphthera* from the Upper Trias of Ipswich within the Tropicuchidae, but further consideration of what is known of the form of the clavus and anal veins of the tegmen, and the very primitive nature of the hindwing, inclines me to keep all the Upper Permian and Upper Triassic genera in a separate family, Prosbolidae.

The following key may be used to distinguish the two fossil families:

- Tegmina with Rs simple and with no transverse division into tough basal and soft distal portions Family *Scytinopteridae*
 Tegmina with Rs branched apically and with a distinct division into tougher basal and softer distal portions Family *Prosbolidae*

Family Scytinopteridae.*

In classifying the Upper Permian genera of this family, it should be noted that M is always fused with R basally for some distance and then comes off from it at a point where there is a more or less marked bend in R. The bent basal vein R+M forms the anterior border of a closed *basal cell*, of which the weaker posterior border is formed firstly by Cu, then by the arching free basal portion of Cu₁; finally the cell is closed distally by a short vein connecting Cu₁ with M close to its origin (this vein almost certainly being homologous with M₅ of the Mecopteroid Orders). In leaving the basal cell, Cu₁ is sometimes a straight vein, sometimes curved markedly downwards so as to come very close to Cu₂. The manner in which R gives off Rs, and the way in which R₁ divides into R_{1a} and R_{1b}, are also valuable characters for classification. Rs is always a simple vein, but the branchings of M and Cu₁ distally vary greatly and are of use in determining genera. The following key will distinguish the tegmina of the known genera of the Australian Upper Permian:

1. The line of R is continued by Rs, R₁ being in the form of an anterior branch; a series of cross-veins present between R₁ and Rs Genus 7. *Permoscarta* Till.
 The line of R is continued by R₁, Rs being a posterior branch; no cross-veins between R₁ and Rs 2
2. The line of R₁ is continued by R_{1a} either as a straight line or a gentle upward curve 3
 R_{1a} not continuing the line of R₁, but placed more transversely, making a definite angle with it 5
3. Cu₁ strongly curved downwards after leaving basal cell, so as to come very close to Cu₂, then diverging from it again; pterostigmatic area long or very long 4
 Cu₁ only slightly curved after leaving basal cell; pterostigmatic area short
 Genus 1. *Permojassus*, n. g.
4. Rs arising at a point more than half-way from base of tegmen; tegmen narrow Genus 3. *Stenosecytina*, n. g.
 Rs arising before half-way from base of tegmen; tegmen broader
 Genus 2. *Orthosecytina*, n. g.

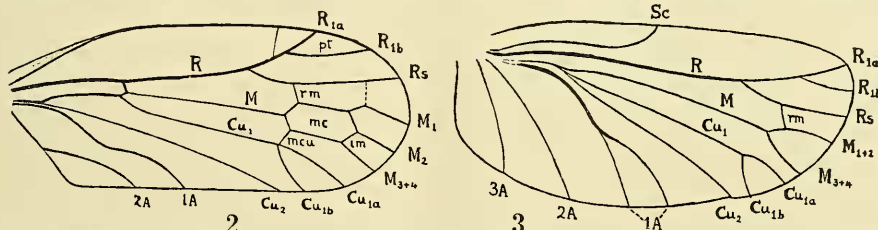
* Besides the numerous representatives of this family in the Upper Triassic of Ipswich, Q., two species have recently been discovered in the Rhaetic of South America, viz., *Wielandia (Tipuloidea) rhaetica* (Wieland) and *Tipulidites affinis* Wieland (*Amer. Journ. Sci.*, 1925, ix, p. 21); they were described by Dr. Wieland as Diptera (Tipuloidea).

5. R_{1a} and R_s arising at same point on R ; distal branches of M and Cu_1 in the form of straight, slightly diverging rays Genus 6. *Actinoscytina*, n. g.
 R_s arising well before R_{1a} ; distal branches of M and Cu_1 curved, dichotomically arranged 6
6. Tegmen of oval form, evenly rounded throughout; Cu_1 with three branches Genus 5. *Elliptoscarta*, n. g.
 Tegmen with margin strongly curved between R_{1b} and R_s , very bluntly rounded apically; Cu_1 with only two branches Genus 4. *Homaloscytina*, n. g.

Genus 1. PERMOJASSUS, n. g. (Text-figs. 2, 3.)

Tegmen.—Sc absent. R straight basally, curving gently upwards distally to end of R_{1a} . R_s short, arising well beyond half-way. R_{1b} and pterostigmatic area (pt) short. Basal cell long and narrow. M three-branched, with median cell (mc) closed by intermedian cross-vein (im). Cu_1 only slightly curved after leaving basal cell, two-branched. Cross-veins rm and mcu present. Clavus triangular, with marked anal angle; 1A sigmoidally curved; 2A arising about half-way down anal margin.

Hindwing.—General scheme of venation closely similar to that of tegmen, but Sc present, strongly curved, ending up about half-way along costa. M only two-branched, with mc and im absent. Cross-vein rm present, mcu absent. Anal area



Text-fig. 2. *Permojassus australis*, n.g. et sp., family Scytinopteridae; Upper Permian of Warner's Bay. Tegmen, with apex turned to right. Length 6 mm. Lettering as in Text-fig. 1, except im , intermedian cross-vein, and mc , closed median cell.

Text-fig. 3. *Permojassus australis*, n.g. et sp., family Scytinopteridae. Hindwing. Length 6 mm. Lettering as in Text-fig. 1.

ample but not expanding beyond the contour of the rest of the wing; 1A sigmoidally curved, but with an extra weak distal branch developed in a straight crease for folding; 2A and 3A fairly straight.

Genotype, *Permojassus australis*, n. sp.

Horizon.—Upper Permian of Warner's Bay and Belmont, N.S.W.

But for the very primitive condition of the hindwing, this genus might be assigned to the Jassidae. Recent Jassidae, however, have the hindwings very different from the tegmina, and with marked differences from the type of hindwing shown in this genus; all of them except those forms which are highly specialized by reduction have a well-developed ambient vein in the hindwing, and many have a similar vein more or less developed on the tegmen. In recent Jassid hindwings, Sc is either absent or fused with the costa; 1A and 2A are fused together basally but diverge distally, making a forked vein, and the anal area folds back just behind this vein. In the tegmen, the form of clavus shown in the fossil is almost typically Jassid, and the structure of M and Cu_1 is closely approached in several genera, but a separate R_{1a} is seldom present, and the costal space is never as broad as in the Scytinopteridae.

While retaining this genus within the Scytinopteridae for the above reasons, we may definitely indicate that the beginnings of the evolution of the enormous

recent family Jassidae are to be found in this Upper Permian Scytinopterid genus. The line of evolution can be followed straight on into the Upper Triassic of Ipswich, where we meet with two genera, *Mesojassus* and *Triassojassus* (Tillyard, 1916, p. 35 and 1919, p. 887), which are evidently direct descendants from *Permojassus* or some closely allied form; these I placed without hesitation in the Jassidae, but this decision rested only on the form of the tegmen, the hindwings not being known. The direct evolutionary line from these forms runs out in such recent genera as *Paropia* (*Megophthalmus*) and *Jassus*, the family as a whole tending towards reduction, though a few forms have added extra veinlets or cross-veins.

1. PERMOJASSUS AUSTRALIS, n. sp. (Text-figs. 2, 3.)

Tegmen 6 mm. long, 2.5 mm. wide. Costal margin very strong and stout at base, gradually narrowing to the point above end of basal cell where it bends to run parallel to the posterior margin; at this point the costal space is about 0.8 mm. wide. A weakly formed costal veinlet can just be made out arising from R_1 a little before its division into R_{1a} and R_{1b} and running transversely to the costa. M arising from $R + M$ by a short transverse piece, and then bending strongly to run straight through the middle of the tegmen until about one-third from apex, when it divides strongly into M_{1+2} above and M_{3+4} below, the former being strongly broken not far from its origin by reception of cross-vein *rm* from R_s , the latter similarly broken by reception of cross-vein *mcu* from the fork of Cu_1 ; further distad, M_{1+2} forks again into M_1 and M_2 while still bounding the cell *mc*, and M_1 is similarly broken by reception of a weakly formed cross-vein from R_s . Cu_1 gently curved, the curve being continued beyond *mcu* by Cu_{1a} , with Cu_{1b} as a posterior branch. Cu_2 ending at two-thirds along posterior margin, which runs past it absolutely straight, without any break or angle in its contour. 1A diverging strongly from Cu_2 in a flatly sigmoidal curve. 2A short, enclosing the well-marked anal angle. An obverse impression, with apex to left.

Hindwing 6 mm. long, 2.6 mm. wide. Costal margin slightly curved basally, then almost straight to end of R_{1a} which is almost at the apex; costal space narrower basally than distally, not so wide as in the tegmen. No costal veinlet before R_{1a} . M free from R basally, but united with Cu, which it leaves by a slight curve just before Cu divides into Cu_1 and Cu_2 , and then runs almost straight to well beyond the level of origin of R_s , when it divides into a single distal fork a little larger than that of Cu_1 below it; *rm* falls on to M_{1+2} without breaking its curve. No other cross-veins present. Posterior margin evenly curved, with perhaps a very slight break at end of Cu_2 . Anal area broad, apparently folding along or slightly basad from 1A and its posterior, straight continuation; basal curved portion of 1A very strongly developed. A reverse impression, with apex to right.

Types: *Holotype tegmen*, Specimen No. 54b, in Mr. Pincombe's Collection; found by him at Warner's Bay, May 6th, 1923; *heautotype hindwing*, Specimen No. 56 in same collection, found at same place and time in same piece of rock not far from the tegmen. Both specimens are on a rather dark grey chert and only moderately well preserved; but with careful lighting all the veins can be made out.

2. PERMOJASSUS DUBIUS, n. sp.

A rather poorly preserved tegmen about 5 mm. long, with basal part of clavus irregularly broken off. As far as it can be made out, the general scheme of

venation is closely similar to that of the previous species, but *im* is very weakly formed and the manner of branching of *M* is different. An obverse impression, with apex to left.

Type: *Holotype tegmen*, Specimen No. 64 in Mr. Pincombe's Collection; found by him at Belmont in 1923 (date not given). The only record, so far, of this genus from Belmont.

Genus 2. ORTHOSCYTINA, n. g. (Text-figs. 4-12.)

Tegmen.—Costa very stout and strongly arched from base, then running absolutely straight nearly to end of R_{1b} , whence the termen or apical margin is very bluntly rounded. Clavus missing in all known specimens, broken off along the deep groove of the *vena dividens*, Cu_2 . Sc present or absent. $R+M$ arched above the basal cell; *R* itself, on leaving the cell, is a very strong vein running absolutely straight or with a very slight upward curve to end of R_{1a} ; consequently the costal space is wedge-shaped, widest at end of cell. R_{1b} and pterostigmatic area long and flat, the latter with or without veinlets. *Rs* arising well before half-way along the tegmen parallel to, or slightly converging towards R_{1b} . *M* with its principal fork at one-third or less from apex, and having from three to five branches altogether. Cu_1 at end of cell either touching *M* or attached to it by a very short vein, then curving away downwards markedly so as to come close to Cu_2 , then diverging from it again, and ending in three or more distal branches.

Genotype, *Orthoscytina mitchelli*, n. sp. (Belmont, N.S.W.).

Horizon.—Upper Permian of Belmont and Warner's Bay, N.S.W.

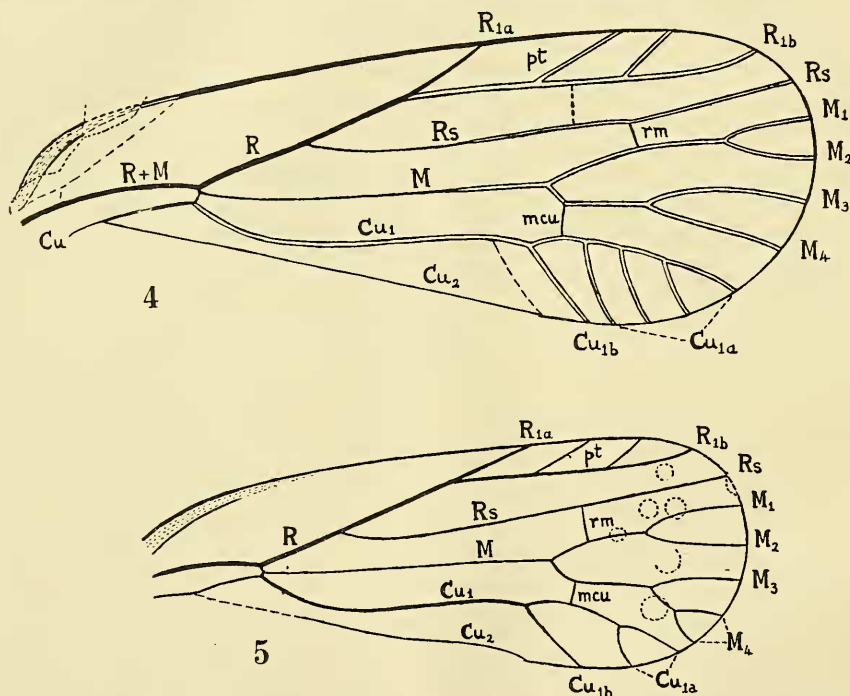
This genus is well characterized by the shape of the tegmen, the strong, straight R_1 and the strongly curved Cu_1 . It appears to have been the dominant genus in the Upper Permian Homoptera, and was probably the ancestral form from which the Upper Triassic genus *Mesocixiodes* was derived. Nine species are known, one from Warner's Bay and eight from Belmont; there are also a number of fragments belonging to this genus, but too incomplete to name.

The species may be distinguished as follows:

1. Pterostigmatic area without veinlets 2
Pterostigmatic area with one or more veinlets 4
2. *Rs* a straight, unbroken vein 3
Rs bent or slightly broken at two points distally where cross-veins connect it with M_{1+2} *O. irregularis*, n. sp.
3. Sc complete; pterostigmatic area very long; Cu_1 with only three branches
Sc absent; pterostigmatic area only moderately long; Cu_1 with four or five branches
..... *O. subcostalis*, n. sp.
..... *O. pincombei*, n. sp.
4. Pterostigmatic area with only a single veinlet 5
Pterostigmatic area with two or three veinlets 6
5. R_{1a} parallel with the pterostigmatic veinlet and of about the same length
..... *O. belmontensis*, n. sp.
 R_{1a} much more oblique than the pterostigmatic veinlet and much longer than it
..... *O. obliqua*, n. sp.
6. Pterostigmatic area with three veinlets; both *M* and Cu_1 with four branches
..... *O. tetranewra*, n. sp.
Pterostigmatic area with only two veinlets; either *M* or Cu_1 or both not four-branched 7
7. Cu_1 with three branches 8
 Cu_1 with five or six branches *O. mitchelli*, n. sp.
8. *M* with three branches *O. indistincta*, n. sp.
M with five branches *O. quinquemedia*, n. sp.

3. ORTHOSCYTINA MITCHELLI, n. sp. (Text-fig. 4.)

Tegmen 10 mm. long, greatest breadth 3.4 mm. near apex. Sc obsolescent, barely indicated as shown by the dotted line in costal space in Text-fig. 4. R absolutely straight from end of basal cell to end of R_{1a} . The whole of R_{1b} and Cu_1 , and all the other veins in the distal half of the tegmen slightly flattened, giving a double outline in the fossil. Pterostigmatic veinlets not at equal intervals and not parallel, the first and second converging towards the costa. Rs slightly curved downwards near origin, very slightly broken at *rm*, slender basally, thickened and flattened distally. M slender basally, thickened and flattened well before its principal fork; branching dichotomically into four distally, the fork of M_{1+2} much smaller than that of M_{3+4} ; the stem of the latter vein strongly bent at *mcu*. Cu_1



Text-fig. 4. *Orthoscytina mitchelli*, n.g. et sp., family Scytinopteridae; Upper Permian of Belmont. Tegmen. Length 10 mm. Lettering as in Text-fig. 1.

Text-fig. 5. *Orthoscytina quinquemedia*, n. sp., family Scytinopteridae; Upper Permian of Warner's Bay. Tegmen. Length 8 mm. Lettering as in Text-fig. 1.

a very strong vein throughout, forking into Cu_{1b} and Cu_{1a} a little before *mcu*; Cu_{1a} having a pectinate series of three branches descending from it. All these branches can be clearly seen as flat veins with double outline if the light be carefully arranged; there are also slight indications of an anterior branch before Cu_{1b} (marked by a dotted line in Text-fig. 4) but this is not certain. Clavus absent. A greyish tegmen on a hard chert of the same colour; obverse, with apex to right.

Type: *Holotype tegmen*, Specimen No. 114 in Mr. Mitchell's Collection; found by him at Belmont in 1925.

This specimen is the best preserved of the eight species so far discovered at Belmont, and is selected as the type for that reason. The Warner's Bay specimen, *O. quinquemedia*, n. sp., is also extremely well preserved, but in all the other species portions of the venation are very faint.

4. *ORTHOSCYTINA QUINQUEMEDIA*, n. sp. (Text-fig. 5.)

Tegmen 8 mm. long, greatest breadth 2.6 mm. near apex. Sc entirely absent. R absolutely straight from end of basal cell to end of R_{1a} . Pterostigmatic veinlets arranged at equal intervals along R_{1b} , subparallel to R_{1a} , but much more weakly formed than that vein. Rs slightly curved downwards near origin, then running straight to apical border, converging towards R_{1b} . M arising from R + M by a very short oblique piece, then running straight through middle of tegmen to its principal fork; the five branches of M are M_1 , M_2 , M_3 and two short ones on M_4 ; no closed median cell. Cross-veins *rm* and *mcu* present but weakly formed, not breaking the curves of the veins to which they are attached. First forking of Cu_1 at a level slightly basad from that of M; second fork placed distally on Cu_{1a} . Clavus absent. Tegmen darker than the rather dark grey chert on which it is impressed, possibly indicating that it was deeply pigmented in life. An obverse impression, with apex to right.

Type: *Holotype tegmen*, Specimen No. 69 in Mr. Pincombe's Collection; found by him at Warner's Bay, July 21st, 1923.

This specimen is the best preserved representative of the genus yet found, and is selected as the genotype for that reason; in the other species, portions of the venation are very faint.

5. *ORTHOSCYTINA INDISTINCTA*, n. sp. (Text-fig. 6.)

Tegmen 9.3 mm. long; greatest width 3.7 mm. A very smooth, indistinct impression on a pale greyish chert, the venation difficult to follow except under strong, oblique light. Sc absent. It differs from the previous species in its larger size, in the slight upward curving of R from end of basal cell to end of R_{1a} , in the irregular arrangement and obliquity of the two pterostigmatic veinlets, in having Rs arising much closer to R_{1b} , and in M being only three-branched, the branches being M_{1+2} , M_3 and M_4 ; *rm* is absent, *mcu* present, and there is no closed median cell. Obverse impression, with apex to left.

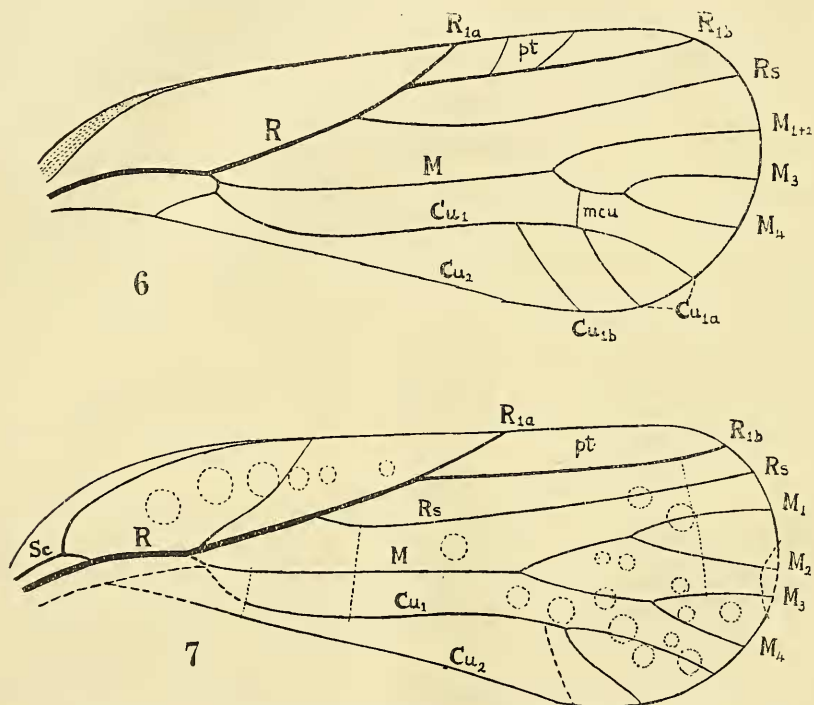
Type: *Holotype tegmen*, Specimen No. 70 in Mr. Mitchell's Collection, found by him at Belmont in 1922.

6. *ORTHOSCYTINA SUBCOSTALIS*, n. sp. (Text-fig. 7.)

Tegmen 9.2 mm. long; greatest breadth 3.7 mm. A rather dark impression on a greyish chert; venation fairly well preserved. In costal space and scattered about on the distal portion also are to be seen circular disc-like impressions, some of them of a paler colour than the rest of the tegmen. These seem to have no relationship to the venation, and are probably the results of bubbles of air or gas having got caught beneath the tough tegmen when settling down in the mud; a few less clearly marked ones are to be seen also on the tegmen of *O. quinquemedia*, n. sp. (Text-fig. 5), and I have seen them on other specimens also. Sc apparently forming a short closed cell basally above R + M and giving off an upwardly curving branch running beneath and converging towards the arched basal part of the costa, which it reaches at about one-third from base. Costal space with a single oblique veinlet arising just beyond end of basal cell, very weak. Pterostigmatic space without veinlets. Rs arising about midway between R_{1b} and M, slightly curved at

first, then running straight and converging slightly towards R_{1b} . M with four branches, arranged dichotomically, and no closed median cell. Distal end of Cu_1 not well preserved, the rock being rough there; actual course of Cu_{1b} not clearly to be made out, but probably as shown by the dotted line in Text-fig. 7. Obverse with apex to left.

Type: *Holotype tegmen*, with counterpart, Specimen No. 4 in Mr. Pincombe's collection; found by him at Belmont in 1922.



Text-fig. 6. *Orthoscytina indistincta*, n. sp., family Scytinopteridae; Upper Permian of Belmont. Tegmen, with apex turned to right. Length 9.3 mm. Lettering as in Text-fig. 1.

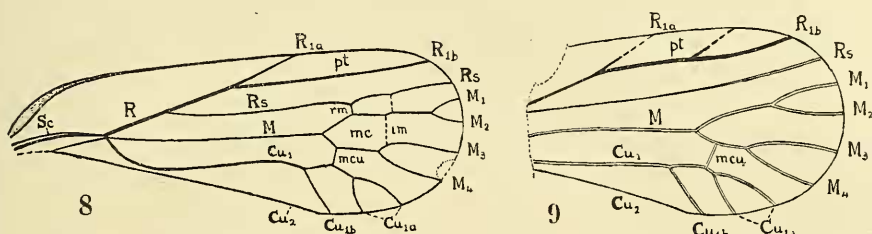
Text-fig. 7. *Orthoscytina subcostalis*, n. sp., family Scytinopteridae; Upper Permian of Belmont. Tegmen, with apex turned to right. Length 9.2 mm. Lettering as in Text-fig. 1.

7. ORTHOSCYTINA IRREGULARIS, n. sp. (Text-fig. 8.)

Tegmen 8.6 mm. long; greatest breadth 3 mm. A rather weak, buff-coloured impression on a greyish-buff chert, the venation requiring careful lighting to follow out. Sc apparently present only as a weak vein running just above $R + M$ and fusing with it towards end of basal cell; costa very strongly formed and greatly curved basally. R absolutely straight from cell to end of R_{1a} . Pterostigmatic area without veinlets. Rs arising about midway between R_{1b} and M, very slightly curved basally, subparallel to R_{1b} ; its course definitely broken at cross-vein rm and again very slightly at a second weaker cross-vein placed more distally below it. R, M and Cu_1 apparently all arising from basal cell at same point. M four-branched, but the distal fork of M_{1+2} very small; this vein is strongly broken

at *rm* and again at two nearly coincident, weaker cross-veins above and below it more distally; of these, the lower is the intermedian, *im*, so that a weakly closed median cell (*mc*) is present. Cross-vein *mcu* strongly formed, bending both M_{3+4} and Cu_{1a} markedly where it meets them. Obverse impression with apex to left.

Type: *Holotype tegmen* and counterpart in Cawthron Institute Collection, on two narrowly wedge-shaped pieces of rock (label "R.J.T., 12.xi.21"), found by myself, at Belmont, Nov. 12th, 1921.



Text-fig. 8. *Orthoscytina irregularis*, n. sp., family Scytinopteridae; Upper Permian of Belmont. Tegmen, with apex turned to right. Length 8.6 mm. Lettering as in Text-fig. 1.

Text-fig. 9. *Orthoscytina belmontensis*, n. sp., family Scytinopteridae; Upper Permian of Belmont. Tegmen, with apex turned to right. Length of fragment, 4.9 mm. Lettering as in Text-fig. 1.

8. ORTHOSCYTINA BELMONTENSIS, n. sp. (Text-fig. 9.)

Tegmen (apical two-thirds only) 4.9 mm. long, representing a total length of about 7.4 mm.; greatest breadth 2.8 mm. The impression is a reverse one, with apex to left, beautifully preserved. R_{1a} and the single pterostigmatic veinlet are both very strong basally, but become somewhat indistinct and weak distally; R_{1b} is a strong, broad vein right to apex. R_s weakly formed except apically, where it tends to become flattened. All the other veins except Cu_2 are flattened, with a double outline. M four-branched, the fork of M_{1+2} somewhat smaller than of M_{3+4} ; no closed median cell present. Cross-vein *rm* absent; *mcu* present, from M_{3+4} on to Cu_{1a} just before its fork.

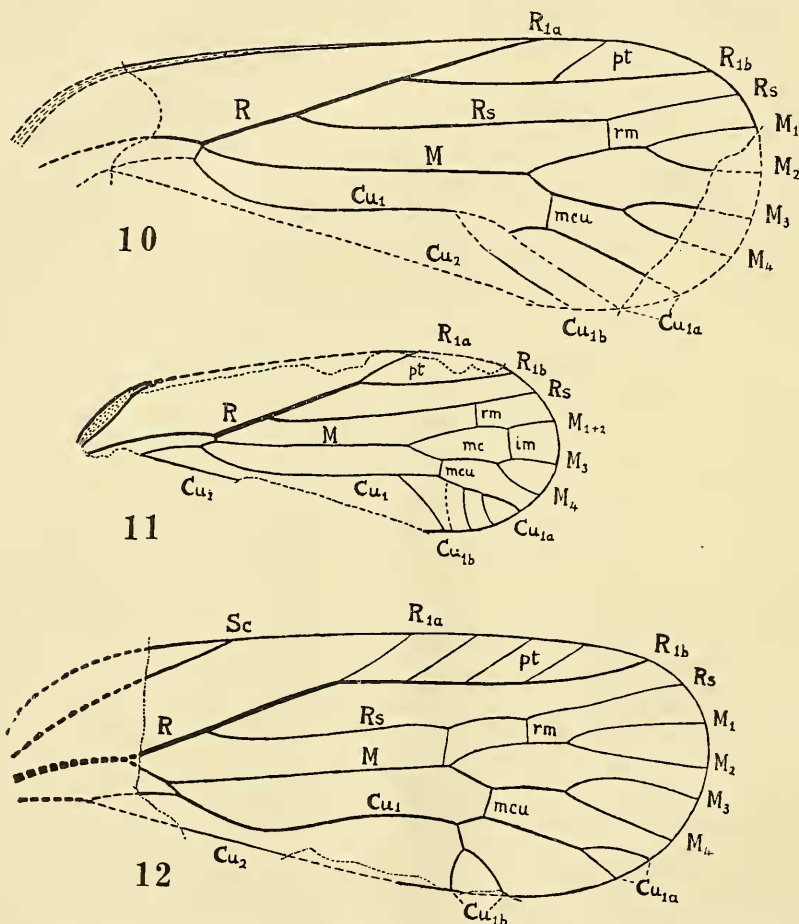
Type: *Holotype tegmen*, Specimen No. 2T in Mr. Pincombe's Collection; found by him at Belmont, February 2nd, 1922.

9. ORTHOSCYTINA OBLIQUA, n. sp. (Text-fig. 10.)

Tegmen with the basal portion, including most of the basal cell, missing, also portion of the apical margin from M_1 to Cu_{1a} obliquely; length of fragment 7.6 mm., indicating a tegmen of total length about 9 mm.; greatest breadth 3.2 mm. A greyish impression on paler and somewhat irregular chert; the courses of Cu_2 and portions of the branches of Cu_1 obliterated; reverse, with apex to right. This species resembles *O. belmontensis*, n. sp., in having only one pterostigmatic veinlet, but differs from it in the marked obliquity of R_{1a} and its consequent much greater length than usual in this genus. R_s is slightly bent at *rm*, and the two apical forks of M are almost equal in size. Cu_1 is apparently three-branched, but the exact courses of the branches are not clearly visible. $R + M$, R , R_{1a} , R_{1b} and main stem of Cu_1 are strong, stout veins, the rest rather weak.

Type: *Holotype tegmen*, Specimen No. 112 in Mr. Mitchell's Collection; found by him at Belmont, 1925.

Two slightly smaller tegmina from Belmont may be provisionally placed in this species, though they are not sufficiently well preserved to make their identity quite certain; these are Specimen No. 63 (T. H. Pincombe, September, 1923) and No. 102 (J. Mitchell, undated). Both show the single pterostigmatic veinlet and the very oblique R_{1a} .



Text-fig. 10. *Orthoscytina obliqua*, n. sp., family Scytinopteridae; Upper Permian of Belmont. Tegmen. Length of fragment, 7.6 mm. Lettering as in Text-fig. 1.

Text-fig. 11. *Orthoscytina pincombei*, n. sp., family Scytinopteridae; Upper Permian of Belmont. Tegmen. Length 7 mm. Lettering as in Text-figs. 1 and 2.

Text-fig. 12. *Orthoscytina tetraneura*, n. sp., family Scytinopteridae; Upper Permian of Belmont. Tegmen, with apex turned to right. Length of fragment, 7 mm. Lettering as in Text-fig. 1.

10. ORTHOSCYTINA PINCOMBEI, n. sp. (Text-fig. 11.)

Tegmen 7 mm. long; greatest breadth 2.6 mm. A rather dark impression on median grey chert; obverse, with apex to right. Costal margin broken away irregularly except at base. R_{1a} not quite in line with R_1 . R_s arising well before

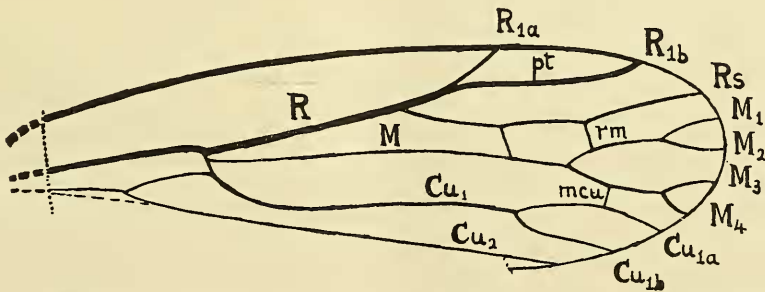
half-way, closer to M than to R_{1b} and converging slightly towards the latter distally. Pterostigmatic area less elongated than in the other species, without any veinlets. Apical border of tegmen somewhat less bluntly rounded than in the other species. Rs arising well before half-way, closer to M than to R_{1b} and converging slightly towards the latter distally. M with three branches, M_{1+2} , M_3 and M_4 , and having a median cell (mc) closed distally by the intermedian cross-vein im falling on to M_3 . Cross-veins rm and mcu both present. Cu_1 with four or possibly five branches (one very indistinct), the extra branches forming a pectinate series on Cu_{1a} as in *O. mitchelli*, n. sp. Most of Cu_2 missing.

Type: Holotype tegmen, Specimen No. 143 and counterpart No. 107 (not seen) in Mr. Pincombe's Collection; found by him at Belmont, Feb. 24th, 1925.

11. ORTHOSCYTINA TETRANEURA, n. sp. (Text-fig. 12.)

Tegmen: Length of fragment 7 mm., indicating a total length of about 8.5 mm.; greatest breadth 3.2 mm. A reverse impression, greyish-buff in colour, on a greyish-white chert, with apex to left. Besides the whole of the clavus and a portion of Cu_2 , the whole of the base is missing up to origin of M. Sc is preserved distally for a short distance as a vein quite distinct from costa, ending up at about level of origin of Rs. R_{1a} a weak vein, exactly similar to the three pterostigmatic veinlets which follow it; these latter are evenly placed, oblique and parallel to one another. Rs slightly waved, converging towards R_{1b} distally, slightly broken in two places where rm and a more basally placed cross-vein connect it with M. Distal forks of M about equal; stem of M_{3+4} broken where it receives mcu , as is also the stem of Cu_{1a} below it. No closed median cell. Cu_1 with four branches, arranged dichotomically. Cu_{1b} arises at level of principal fork of M and its stem is placed much more transversely than usual; its apical fork is slightly larger than that of Cu_{1a} , much smaller than those of M.

Type: Holotype tegmen, Specimen No. 7T in Mr. Pincombe's Collection; found by him at Belmont, July 14th, 1922.



Text-fig. 13. *Stenoscytina australiensis*, n.g. et sp., family Scytinopteridae; Upper Permian of Belmont. Tegmen. Length 7.2 mm. Lettering as in Text-fig. 1.

Genus 3. STENOSCYTINA, n. g. (Text-fig. 13.)

A genus somewhat of the type of *Orthoscytina*, n. g., but having the tegmen much narrower, R curving gently upwards to end of R_{1a} , the pterostigmatic region not so markedly elongated, the costa evenly curved from base to apex. Rs arises well beyond half-way, fairly close to R_{1b} . M four-branched, the apical forks being dichotomically arranged and small. Cu_1 curves markedly downwards on leaving

basal cell, so as to come close to Cu_2 , then diverges from it again and has a single large apical fork. Cu_2 ends on posterior margin at about three-fourths of wing-length. Clavus missing, but evidently narrower than usual for the family.

Genotype, *Stenoscytina australiensis*, n. sp.

Horizon.—Upper Permian of Belmont, N.S.W.

12. STENOSCYTINA AUSTRALIENSIS, n. sp. (Text-fig. 13.)

Tegmen 7.2 mm. long, with extreme base broken off, representing a total length of about 7.6 mm.; greatest breadth 2.4 mm.

$R+M$ nearly straight, making the costal space of more even width basally than usual in the family. No pterostigmatic veinlets present. Rs slightly broken at two places where cross-veins pass from it to M , viz. rm on to M_{1+2} and a more basal one on to main stem of M ; the latter is slightly curved upwards towards Rs about the middle. No closed median cell present; mcu present, from middle of M_{3+4} to about middle of Cu_{1a} . Apical fork of Cu_1 rather long and narrow. A reverse impression in fair condition, apex to right.

Type: *Holotype tegmen*, Specimen No. 77 in Mr. Mitchell's Collection; found by him at Belmont in 1922.

Genus 4. HOMALOSCYTINA, n. g. (Text-fig. 14.)

This is the first of a group of genera in the tegmina of which R_{1a} , instead of being in line with R_1 , makes a marked angle with it, being much more transversely placed. Costa strongly curved basally, slightly curved distally, termen or apical margin rather bluntly rounded. Pterostigmatic area moderately long. Rs arising well beyond half-way. M four-branched, Cu_1 two-branched, running straight from basal cell to fork.

Genotype, *Homaloscytina plana*, n. sp.

Horizon.—Upper Permian of Warner's Bay, N.S.W.

13. HOMALOSCYTINA PLANA, n. sp. (Text-fig. 14.)

Tegmen 6.4 mm. long; greatest breadth 2.7 mm. A fair obverse impression with apex to right, venation weak, colour dark grey on a medium grey chert. No pterostigmatic veinlets present. Rs arising much closer to R_{1b} than to M , diverging slightly from R_{1b} distally. Forks of M dichotomically arranged, that of M_{1+2} smaller than that of M_{3+4} ; mcu the only cross-vein present, causing a marked break in M_{3+4} where it meets it. Cu_1 running straight from basal cell to end of Cu_{1a} , with Cu_{1b} as a posterior branch. Cu_2 parallel with Cu_1 , ending at about two-thirds along posterior margin. Basal cell broader than usual for the family.

Type: *Holotype tegmen*, Specimen No. 59 in Mr. Pincombe's Collection; found by him at Warner's Bay on December 1st, 1923.

Genus 5. ELLIPTOSCARTA, n. g. (Text-fig. 15.)

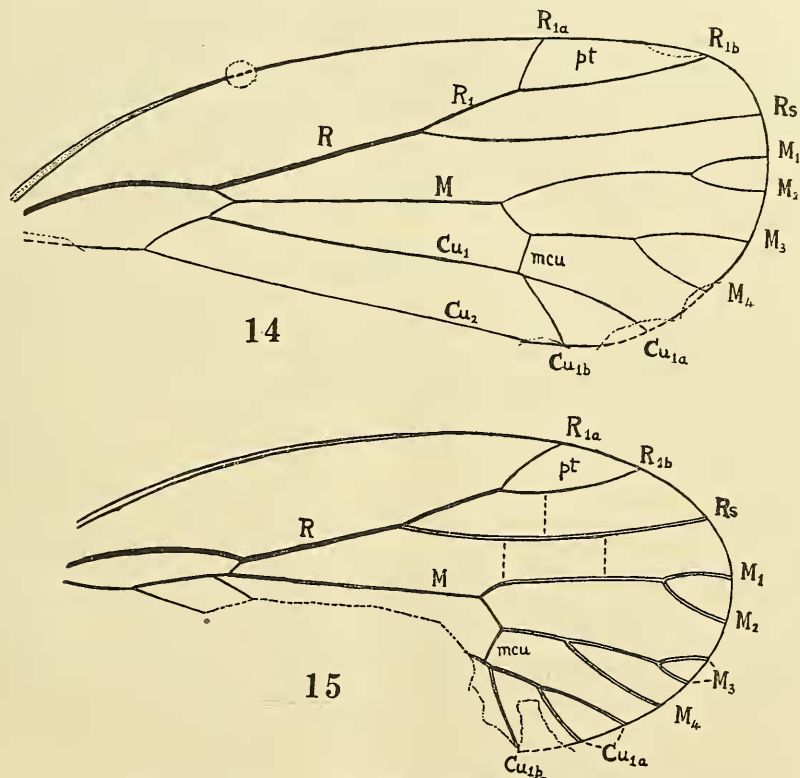
Tegmen broadly oval, with wide costal space. Pterostigmatic area short, its length along costa only about equal to the length of R_{1a} ; forking of R_1 dichotomic. Rs arises a little beyond middle much nearer to R_{1b} than to M . M five-branched. Cu_1 three-branched (the course of its main stem missing in the fossil).

Genotype, *Elliptoscarta ovalis*, n. sp.

Horizon.—Upper Permian of Belmont, N.S.W.

14. *ELLIPTOSCARTA OVALIS*, n. sp. (Text-fig. 15.)

Tegmen 5.3 mm. long, greatest breadth 2.4 mm. A darkish reverse impression, with apex to right, on medium grey chert; venation moderately clear. Apical veins, from R_s to Cu_{1b} , tending to become flattened, giving a double outline in the fossil. A large break has carried away not only the clavus but a considerable area above it, including all but the basal parts of Cu_2 and main stem of Cu_1 . R_s



Text-fig. 14. *Homaloscytina plana*, n.g. et sp., family Scytinopteridae; Upper Permian of Warner's Bay. Tegmen. Length 6.4 mm. Lettering as in Text-fig. 1.

Text-fig. 15. *Elliptoscarta ovalis*, n.g. et sp., family Scytinopteridae; Upper Permian of Belmont. Tegmen. Length 5.3 mm. Lettering as in Text-fig. 1.

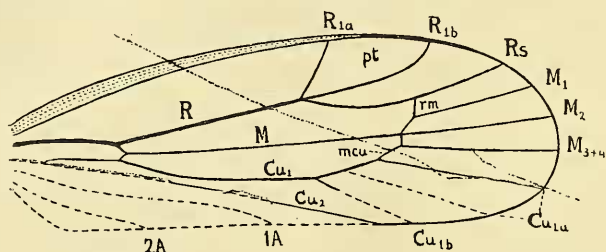
slightly curved, diverging slightly from R_{1b} distally. M running straight through middle of tegmen, forking a little before one-third from apex; its five apical branches are M_1 , M_2 , two short branches on M_3 , and a fairly long M_4 ; the only clear cross-vein is mcu , which breaks the line of M_{3+4} very strongly where it arises, but there are slight indications of three much weaker cross-veins in the positions indicated by dotted lines in Text-fig. 15. Cu_{1b} arises just distad from mcu ; Cu_{1a} has an apical fork.

Type.—*Holotype tegmen*, Specimen No. 150 in Mr. Pincombe's Collection; found by him at Belmont, February 23rd, 1925.

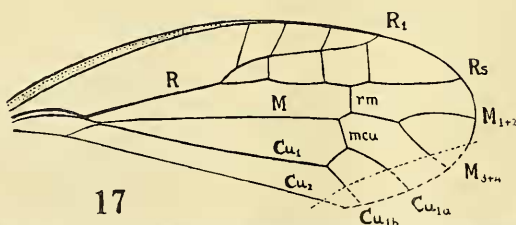
In its small size, well rounded shape and flattening of the distal veins, this tegmen shows a distinct approach to the very small Sternorrhynchous forms described below, and undoubtedly indicates the line of evolution in these characters which led to that Division. In its venation and in the great breadth of its costal space, the fossil belongs to the Scytinopteridae; it would be very interesting to discover the clavus and to see whether it had begun to undergo any reduction.

Genus 6. ACTINOSCYTINA, n. g. (Text-fig. 16.)

A somewhat isolated type in which the tegmen is distinguished at once by having the origin of R_s and R_{1a} at the same point on R , beyond half-way, and by the arrangement of the distal branches of M and Cu as straight, slightly diverging rays. Costal strongly arched from base to apex, very stout, especially from base to R_{1a} . Pterostigmatic area short and deep, with R_{1a} very transversely placed and nearly as long as the distance from it to R_{1b} on the costa. M running straight through middle of wing to end of M_3 . Cu_1 curved concavely to M ,



16



17

Text-fig. 16. *Actinoscytina belmontensis*, n. g. et sp., family Scytinopteridae; Upper Permian of Belmont. Tegmen, with apex turned to right. Length 7 mm. Lettering as in Text-fig. 1.

Text-fig. 17. *Permoscarta trivenulata*, n. sp., family Scytinopteridae; Upper Permian of Warner's Bay. Tegmen, with apex turned to right. Length 6 mm. Lettering as in Text-fig. 1.

approaching very close to Cu_2 at a point not far from basal cell. M and Cu_1 each with three distal branches, arranged at about equal intervals as diverging rays to the wing-margin. Posterior margin distally very straight, suggesting that the missing clavus was of the form shown by the dotted lines in Text-fig. 16.

Genotype, *Actinoscytina belmontensis*, n. sp.

Horizon.—Upper Permian of Belmont, N.S.W.

15. ACTINOSCYTINA BELMONTENSIS, n. sp. (Text-fig. 16.)

Tegmen 7 mm. long; greatest breadth 2.4 mm. A medium greyish impression on chert of the same colour, obverse, with apex to left; venation fairly clear. The

tegmen is damaged by a slight crack running obliquely across it as shown in Text-fig. 16, and by abrasions of the rock which partially obliterate the courses of the branches of Cu_1 . R_{1b} curving strongly upwards to costa. Cross-veins *rm* and *mcu* combine with bent basal pieces of M_1 , M_{3+4} and Cu_{1a} to form an irregular but complete *transverse cord*, of the type found in many *Perlaria* and *Trichoptera*, running from origin of Cu_{1b} right up to Rs and forming the distal boundary of a large central cell bounded anteriorly by R and Rs , posteriorly by Cu_1 , and divided into two by the straight vein M . From this cell the distal veins radiate out to the margin.* In Text-fig. 16 the restored clavus is shown by dotted lines, as are also the two lower branches of Cu_1 which are almost obliterated in the fossil.

Type.—*Holotype tegmen*, Specimen No. 85 in Mr. Pincombe's Collection; found by him at Belmont, August 8th, 1924.

Genus 7. PERMOSCARTA Till. (Text-fig. 17.)
Tillyard, 1918, p. 726.

This genus was proposed by me for the reception of a small tegmen found by Mr. Mitchell in shale just above the Dirty Seam, Newcastle, N.S.W., which I named *Permoscarta mitchelli* and placed in the family Cercopidae owing to its resemblance to the tegmen of the recent genus *Eoscarta*. It seems quite clear that the Cercopidae are directly descended from the Scytinopteridae, and that the group of genera of which *Eoscarta* is a representative must have evolved from forms resembling *Permoscarta*. The latter, however, is a true Scytinopterid in all but the loss of a definite R_{1a} , and I have already (1919, pp. 868, 875) removed it to that family.

This genus stands well apart from all other Upper Permian genera of the family in the complete loss of a definite R_{1a} . R forks only once, at a point before half-way along the tegmen, into R_1 (equivalent to R_{1b} in other forms) and Rs , the two branches being connected by a series of inter-radial cross-veins, not found in any other genus. Rs continues the line of R distally, while R_1 arches up as an anterior branch; between it and the costa is a series of veinlets of which the first is probably the reduced R_{1a} and the others pterostigmatic veinlets. M and Cu_1 are straight veins diverging from the basal cell and only branching far distally; both have only two branches. Cross-veins *rm* and *mcu* are present.

Genotype, *Permoscarta mitchelli* Till.

Horizon.—Upper Permian of Newcastle and Warner's Bay, N.S.W.

The two known species may be distinguished as follows:

Seven costal veinlets above R_1 ; six inter-radial cross-veins; M with more than two distal branches	<i>P. mitchelli</i> Till.
Three costal veinlets above R_1 ; three inter-radial cross-veins; M with only two distal branches	<i>P. trivenulata</i> , n. sp.

16. PERMOSCARTA MITCHELLI Till.
Tillyard, 1918, p. 728.

In this species R_1 arises at a point not far distad from end of basal cell; the first costal veinlet slants somewhat backwards from R_1 to costa, the second is transverse and the rest slant forwards towards the apex. M is slightly bent at *mcu*

* Compare with this formation the closely similar one found in most *Lepidoptera*, where, however, the main stem of M becomes obsolete in all but the more archaic families.

and again at *rm* and ends in a tiny distal fork; Cu_{1a} is strongly broken where *mcu* falls upon it; distal fork of Cu_1 small, but considerably larger than that of *M*.

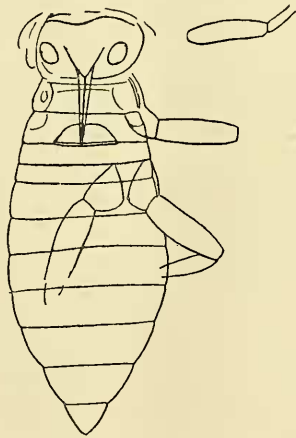
Type: *Holotype tegmen*, Specimen No. 23 in Mr. Mitchell's Collection; found by him in shale above Dirty Seam, Newcastle.

17. PERMOSCARTA TRIVENULATA, n. sp. (Text-fig. 17.)

Tegmen 6 mm. long; greatest breadth 2.1 mm. A somewhat dark obverse impression, with apex to left, on greyish chert; clavus and posterior part of termen missing. *Sc* apparently present as a short, separate vein just above *R* + *M*. Costa very stout, well arched from base to apex. *R* forking not much before half-way, R_1 arching upwards and slightly sigmoidally curved, giving off three costal veinlets all of which slant slightly forwards towards apex. *Rs* diverging from R_1 , ending up a little before apex; three inter-radial cross-veins unite R_1 with *Rs*, the latter vein being slightly bent at the point of union with each cross-vein and also at origin of *rm*. *M* markedly bent at both *mcu* and *rm*, the latter being slightly more distally placed than the former; apical fork of *M* much larger than in *P. mitchelli* Till., somewhat longer than the main stem from *rm* to fork. Fork of Cu_1 a little larger than that of *M*; the curve of Cu_{1a} strongly broken where it receives *mcu*.

Type: *Holotype tegmen*, Specimen No. 82 in Mr. Pincombe's Collection; found by him at Warner's Bay, July 14th, 1923.

Besides the above, Specimen No. 50 in Mr. Pincombe's Collection, found at Belmont, March 18th, 1923, represents the body of a Homopterous insect, almost certainly a Scytinopterid, 5 mm. long, dorso-ventral impression. The outline



Text-fig. 18. Body of a Scytinopterid, from Upper Permian of Belmont. Length, 5 mm.

is rather faint, but the head and eleven segments can be seen, these being, as far as I can make out, the meso- and metathorax and nine abdominal segments; the prothorax is probably covered by the head. The antennae are missing, but the compound eyes can be seen, fairly wide apart; in between them is a triangular piece from which the beak projects backwards to the distal end of the metathorax. The legs have become detached from the body, but four of them are still present

in part, viz. a femur and part of the tibia of a foreleg, displaced to the right of the head, a coxa and femur of a middle leg, the former overlying the right margin of the metathorax with the femur projecting at right angles to it, and the two hindlegs with their rather large, trapezoidal coxae nearly contiguous, lying upon the right half of abdominal segments 2-3, the broad femora attached to them, and a part of the right tibia also present at an angle to the femur. General shape of body broadly fusiform, the head a little wider than the mesothorax, the abdomen widest at seg. 5, tapering to a conical end-segment. Text-fig. 18 is a somewhat diagrammatic representation of this fossil.

Family *Prosbolidae*.

The fossils included in this family are usually of considerably larger size than the *Scytinopteridae*; the tegmina are broad, with strong costal margin, wide costal space and strong radius. The basal cell is either very short, or else elongated and very narrow. The costa may be notched either at or before the apex of R_{1+2} , forming a kind of nodus. Rs is distally branched. There is a differentiation in the texture of the membrane of the basal and distal portions of the tegmen, the basal portion being markedly tougher than the distal, sometimes granulate or tuberculate; a more or less distinct line of demarcation can be made out between the two portions, as in recent *Tropiduchidae*. The softness of the distal membrane sometimes results, during fossilization, in tearing or crumpling of that part, so that the impression is incomplete, worn or buckled distally. The clavus has the two anal veins widely separated from one another. The hindwings are broadly oval, with exceedingly strong radius and first cubitus, Rs distally branched, the anal area not very large and only slightly folded.

This family appears to have been ancestral to recent *Fulgoroidea*, the connection being closest with the *Tropiduchidae*. The most perfect of the new fossil tegmina shows a rounded swelling at the base of the costa, very suggestive of the tegula characteristic of the *Fulgoroidea*. Almost all recent *Fulgoroidea* have the two anal veins fusing distally to form a Y-vein. An examination of the clavus in *Prosbolidae* shows that $1A$ is already in position for this, curving towards $2A$ a little beyond half-way, and then converging strongly towards Cu_2 and nearly meeting it distally; the Y-vein is completed by $2A$ turning distally away from the margin towards the curved part of $1A$ and fusing with it.

The peculiar tendency towards a division of the tegmen into two very distinct parts, a basal *corium* and a distal *membrane*, which becomes a diagnostic character for the whole Suborder Heteroptera seems to crop up to a greater or less extent in various groups of Homoptera also, e.g. in many *Cicadidae*, in the *Tropiduchidae*, and in this fossil family *Prosbolidae*. The question might be asked, why are these fossils not classified as true Heteroptera? The answer is that, in true Heteroptera, the form of the clavus is very different from that of the *Auchenorrhyncha*, being correlated with the manner of folding the hemielytra flatly down on the abdomen with their distal portions completely overlapping; there is, consequently, always a marked angle at the end of Cu_2 between the claval and distal portions of the posterior margin, whereas in the *Auchenorrhyncha* the posterior margin is straight. It is very instructive to note that the Lower Permian family *Permoscytinidae* and a number of the known *Copeognatha* of the same age show a slight break in the contour of the posterior margin of the forewing at end of Cu_2 . From some archaic form possessing this character to a somewhat more marked degree the Heteroptera must have arisen.

Three genera of Prosbolidae are known from the Upper Permian of Australia, and may be distinguished as follows:

1. Tegmina less than 15 mm. long, with main stem of M present 2
Hindwings more than 15 mm. long, with main stem of M obsolescent
..... Genus 10. *Mitchelloneura* Till.
2. Basal cell long and narrow, one-fourth or more of the total length of tegmen
..... Genus 8. *Permoglyphis*, n. g.
Basal cell very short, at most only one-eighth of the total length of tegmen
..... Genus 9. *Permodiphthera*, n. g.

Genus 8. PERMOGLYPHIS, n. g. (Text-fig. 19.)

Tegmen: Costa very strongly formed, moderately curved from base to nodus (*n*), where it is markedly bent; apical portion of tegmen evenly rounded. At base of costa is a nearly circular, plate-like swelling (*tg*), probably representing the *tegula* of recent Fulgoroidea. Sc short, weakly formed. Basal cell long and narrow, reaching to beyond one-fourth of the total length of the tegmen. From the nodus, a faint, curved, transverse line divides the tegmen as far as Cu₂ into a somewhat roughened, granulate basal portion and a very smooth distal portion; on this latter all the larger veins are somewhat flattened, giving a double outline in the fossil impression. No strongly marked R₁₊₂ present, but only a series of pterostigmatic veinlets. Rs arising just basad from the dividing line from nodus, and having a small distal fork. Main stem of M distinct, forking irregularly beyond dividing line. Cu, strongly curved convexly to Cu₂, with large apical fork arising on the dividing line. Cu₂ straight, ending almost exactly below level of nodus. Clavus triangular, with marked anal angle; 1A long, gently curved sigmoidally; 2A short, closing the anal angle.

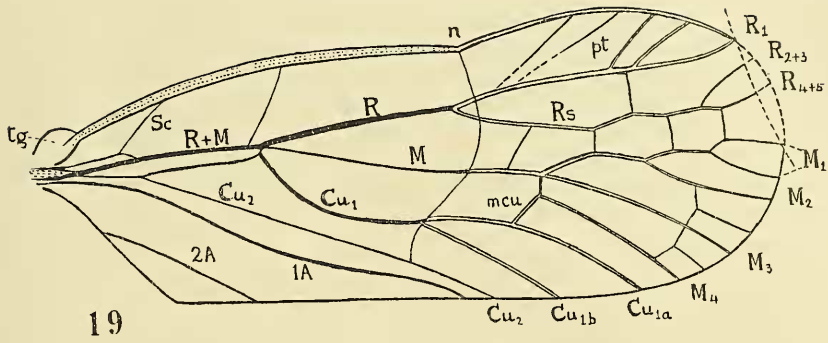
Genotype, *Permoglyphis belmontensis*, n. sp.

Horizon.—Upper Permian of Belmont, N.S.W.

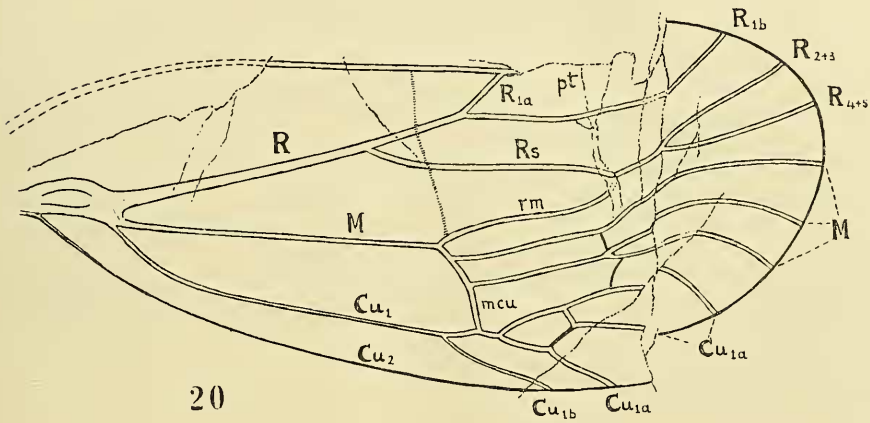
18. PERMOGLYPHIS BELMONTENSIS, n. sp. (Text-fig. 19.)

Tegmen perfect except for a very small portion of apical margin cut off between ends of R₁ and M₁; total length 9.4 mm.; greatest breadth 3.6 mm. A very fine obverse impression, with apex to right, greyish-white on chert of the same colour. The *tegula* (*tg*) is very strongly marked, its outer margin almost semicircular. Sc very short, ending up on R + M before half the length of the basal cell, and sending a faint branch obliquely upwards to costa. A single faint costal veinlet arising from R + M just before end of basal cell. Pterostigmatic veinlets four, arranged in two groups of two each close together; the first two weak, not clearly marked basally (partially obliterated by a local roughness of the rock surface), the second two shorter but well formed. Rs connected with R₁ by a single cross-vein, with M by four cross-veins, and slightly zigzagged at point of origin of each cross-vein except the first. M₁₊₂ also slightly zigzagged at the three cross-veins which join it to Rs; M₁ with an extra distal fork. M₃ continues the line of the main stem of M, while what appears to be M₄ arises from it by a short transverse piece at point of origin of M₁₊₂ and connected with Cu₁₊₂ by a strong cross-vein. Between M₂ and M₃, and also between M₃ and M₄ are short interpolated distal veins connected by cross-veins above and below. 1A ending very close to Cu₂.

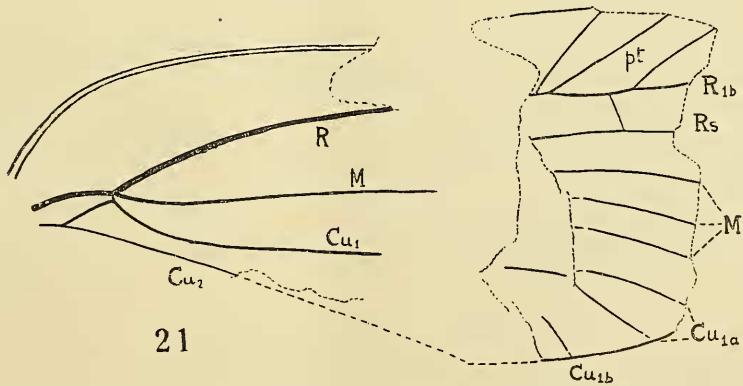
Type: *Holotype tegmen*, Specimen No. 117 in Mr. Mitchell's Collection; found by him at Belmont, 1925. One of the most perfect specimens yet discovered in these beds.



19



20



21

Text-fig. 19. *Permoglyphis belmontensis*, n.g. et sp., family Prosbolidae; Upper Permian of Belmont. Tegmen. Length 9.4 mm. Lettering as in Text-fig. 1, except *n*, nodus, and *tg*, tegula.

Text-fig. 20. *Permodiphthera robusta*, n.g. et sp., family Prosbolidae; Upper Permian of Belmont. Tegmen. Length 11 mm. Lettering as in Text-fig. 1.

Text-fig. 21. (?) *Permodiphthera dubia*, n. sp., family Prosbolidae; Upper Permian of Belmont. Tegmen. Length 11 mm. Lettering as in Text-fig. 1.

Genus 9. PERMODIPHATHERA, n. g. (Text-figs. 20, 21.)

Tegmen: Costa strongly curved basally, then running fairly straight to R_{1a} or beyond; apex well rounded. Basal cell very small, at most only one-eighth the length of the tegmen. R very stout, straight or slightly curved. Rs distally forked. Main stem of M straight or very gently curved. Main stem of Cu_1 strongly curved downwards so as to come fairly close to Cu_2 not far from basal cell. Both M and Cu_1 with three or four branches distally.

Genotype, *Permodiphthera robusta*, n. sp.

Horizon.—Upper Permian of Belmont, N.S.W.

19. PERMODIPHATHERA ROBUSTA, n. sp. (Text-fig. 20.)

Tegmen 11 mm. long, with distal portion crumpled, representing an actual length of about 13 mm.; greatest breadth 5.2 mm. An obverse impression on grey shale, with apex to right. Clavus and basal portion of costa missing, the latter being cut off by an oblique, irregular break in the rock; a portion of the costa in the pterostigmatic region is also missing, and the main fold in the crumpling of the soft distal portion of the tegmen runs transversely from the end of this break to a point between the ends of the branches of Cu_{1a} , where the margin is badly torn. Division between hard and soft parts is indicated by a transverse dividing line from costa a little before R_{1a} to principal fork of M; below that it is carried on by a strongly bent portion of M, continued by *mcu*. Pterostigmatic area fairly long and deep, without veinlets. Rs connected with M by a long, sigmoidally curved vein which appears to be the specialized *rm*. Owing to the crumpling, the distal branches are not easy to follow out, but M appears to have three branches and Cu_1 four, *mcu* falling on Cu_{1a} before its first branch is given off. Cu_2 somewhat curved.

Type: *Holotype tegmen*, Specimen No. 72 in Mr. Mitchell's collection; found by him at Belmont in 1922.

20. (?) PERMODIPHATHERA DUBIA, n. sp. (Text-fig. 21.)

Tegmen 11 mm. long with apical portion missing, representing a total length of about 13 mm.; greatest breadth about 5 mm. This is an obverse impression with apex to right; clavus and apical portion missing, middle portion obliterated. It differs from *P. robusta*, n. sp., in having R distinctly curved, M slightly curved basally, Cu_2 apparently straight, pterostigmatic veinlets present, also a cross-vein between R_{1b} and Rs; the distal venation is too fragmentary to determine in detail. Probably this species should be placed in a new genus, but it would be better to leave it provisionally in *Permodiphthera* until a better specimen is available.

Type: *Holotype tegmen*, Specimen No. 144 in Mr. Pincombe's Collection; found by him at Belmont, Feb. 24th, 1925.

Genus 10. MITCHELLONEURA Till.

Tillyard, 1922a, p. 414, Text-fig. 1.

Genotype, *Mitchelloneura permiana* Till.

Horizon.—Upper Permian, Merewether Beach, Newcastle, N.S.W.

21. MITCHELLONEURA PERMIANA Till.

The fine hindwing on which this species is based has a total length of 17 mm., greatest breadth 7 mm. R immensely strong, with Rs arising about one-fourth

from base. Rs three-branched, the upper branch fusing with R_{1b} . M and Cu_1 both three-branched. A fair number of weak, irregular cross-veins in distal part of wing.

Type: *Holotype hindwing*, in Mr. Mitchell's Collection; found by him in 1921 in a piece of burnt shale from the railway embankment at Merewether Beach.

Besides the above, the very large clavus shown in Text-fig. 22 appears to belong to this family, possibly to the genus *Mitchelloneura*. Total length of fragment 14.5 mm., representing a tegmen which must have been nearly an inch long. The two anal veins are quite separate, as in Scytinopteridae, the anal margin very strong, the anal angle obtusely rounded. This specimen is No. 90 in Mr. Mitchell's Collection, and was found by him at Belmont (date not given).

Division **Sternorrhyncha.**

In this division we place those small fossil tegmina, 6 mm. or less in length, in which the clavus has undergone more or less reduction, with or without loss of one or both anal veins; the great majority of forms have a very narrow clavus without any venation on it at all. The oldest known representative of this Division is *Permopsylla americana* Till. (Text-fig. 23), the only Sternorrhynchous form known from the Lower Permian of Kansas. If this be compared with the Auchenorrhynchous *Permoscytina kansasensis* Till., from the same horizon, a close general resemblance in the venations of the two types will at once be noticed, viz. Sc closely parallel to R, R_1 dividing into a short R_{1a} and a long R_{1b} , with long pterostigmatic area between it and costa, M three-branched, Cu_1 two-branched, cross-veins *rm* and *mcu* present. It is only in the great reduction in length of the tegmen, its broader and more oval form, and in the strong reduction of the clavus with loss of its anal veins, that *Permopsylla* differs from *Permoscytina*.

The Australian Upper Permian beds have yielded the richest Sternorrhynchous fossil fauna yet discovered, some of them being even more archaic than *Permopsylla* itself in that they still retain one or both anal veins on the reduced clavus. Three distinct families may be recognized, according to the following key:

1. R_1 simple 2
 R_1 dividing into a short R_{1a} and a longer R_{1b} , enclosing between them a well-defined pterostigmatic area Family *Permopsyllidae*
2. Two anal veins present; Rs simple; M three-branched Family *Pincombeidae*
 Anal veins absent; Rs forked; M two-branched Family *Lophioneuridae*

Family **Pincombeidae.**

Sc separate from R, well-developed. R_1 simple. Rs simple. M three-branched. Cu_1 two-branched. Clavus very narrow, with 1A and 2A well developed, close together and parallel.

Genus 11. PINCOMBEA Till.

Tillyard, 1922*b*, p. 282, 281, Text-fig. 2.

Genotype, *Pincombea mirabilis* Till.

Horizon.—Upper Permian of Belmont, N.S.W.

22. PINCOMBEA MIRABILIS Till.

This beautifully preserved tegmen, only 3 mm. long, was found by Mr. Pincombe at Belmont in 1922, and is in Mr. Mitchell's Collection (Specimen

No. P.2). The costa is somewhat flat, the costal space rather narrow, the apex of the wing at end of R_1 , the termen or apical margin very wide. R_s arises a little before half-way. M forks at about middle of wing, the extra fork being on M_{1+2} , with cross-vein rm above M_1 . Cross-vein mcu absent. Cu_1 has a large distal fork. Basal cell barely formed owing to the very weak condition of the basal portions of Cu and Cu_1 . Cu_2 runs straight to the posterior margin so as practically to meet Cu_{1a} , and $1A$ runs so as to end up very close to Cu_2 , $2A$ being a little behind it.

Family Permopsyllidae.

Sc present or absent. R_{1a} present. R_s simple. M with two or three branches. Cu_1 two-branched. Clavus without anal veins, or with one only.

This family contains four genera, viz. *Permopsylla* Till. from the Lower Permian of Kansas, and three new genera from the Upper Permian of Australia. They may be distinguished as follows:

1. Sc present, pterostigmatic area elongated 2
 Sc absent, pterostigmatic area moderate or short 3
2. Sc complete but closely parallel to R_1 ; pterostigmatic area not strongly chitimized (Genus *Permopsylla* Till. Lower Permian of Kansas)
 Sc only separate basally, fused distally with R_1 ; pterostigmatic area narrowly triangular, strongly chitimized to form a true pterostigma Genus 14. *Permothea*, n. g.
3. R_s arising closer to basal cell than to R_{1a} Genus 12. *Protopsyllidium*, n. g.
 R_s arising closer to R_{1a} than to basal cell Genus 13. *Permopsyllidium*, n. g.

Genus 12. PROTOPSYLLIDIUM, n. g. (Text-fig. 24.)

Tegmen broadly oval. Sc absent. $R+M$ strongly arched. R running practically straight to end of R_{1b} at about two-thirds from base. Pterostigmatic area moderate, about two and a half times as long as the oblique R_{1a} . R_s arising closer to basal cell than to R_{1a} , slightly sigmoidally curved, diverging from R_1 . Basal cell well-formed, about one-eighth as long as tegmen. M running straight through middle of tegmen, forking only once, at about two-thirds from base. Cu_1 slightly curved, forking well before middle of tegmen. $1A$ parallel to Cu_2 for most of its length, diverging slightly apically. No cross-veins except a short basal one connecting Cu_2 with $1A$.

Genotype, *Protopsyllidium australe*, n. sp.

Horizon.—Upper Permian of Warner's Bay, N.S.W.

23. PROTOPSYLLIDIUM AUSTRALE, n. sp. (Text-fig. 24.)

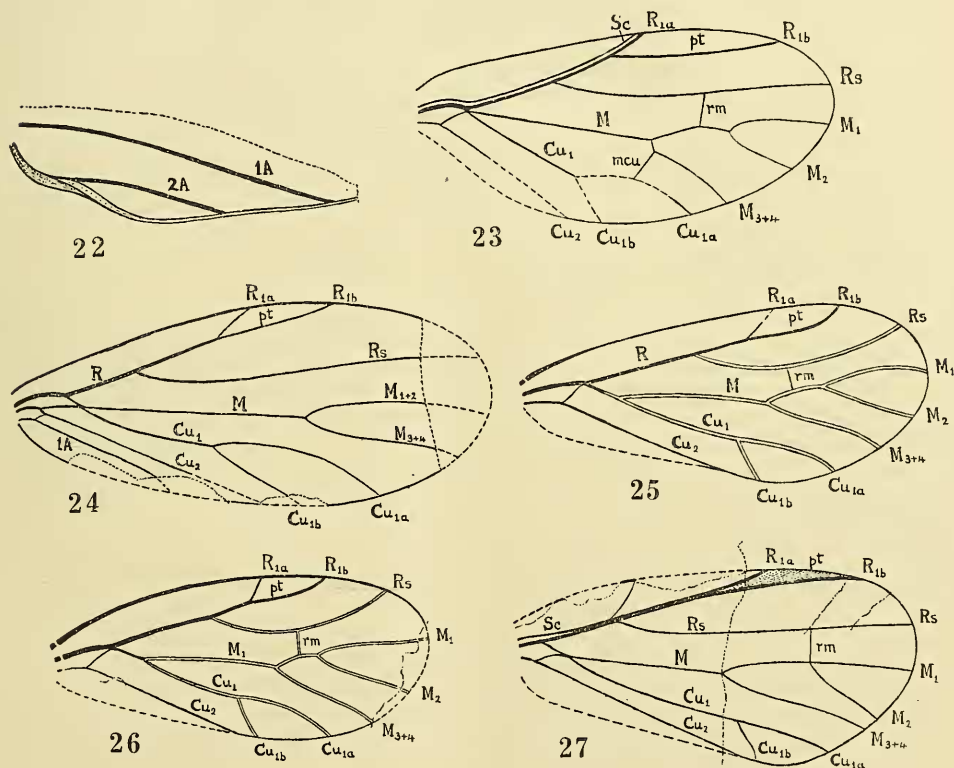
Tegmen with apex missing, 2.8 mm. long, representing a total length of about 3.3 mm.; greatest breadth 1.4 mm. A dark grey impression on a rather dark grey chert; obverse, with apex to right. The apex is cut off transversely by a break in the rock (missing portion restored by dotted lines in Text-fig. 24); there are also shallow breaks along the posterior margin as indicated in Text-fig. 24. The great distance apically between R_{1b} and R_s is remarkable, and is due partly to the shortness of R_1 and partly to the slight sigmoid curvature of R_s . Main stem of M considerably longer than its rather large fork. Main stem of Cu_1 about as long as its fork. Cu_2 ending a little beyond half-way on posterior margin.

Type: *Holotype tegmen*, Specimen No. 140 in Mr. Pincombe's Collection; found by him in a large block of chert brought by him from Warner's Bay in 1924,

and broken open subsequently at his home; this tegmen was discovered on Sept. 12th, 1925, and six other specimens have also been taken from the same block, of which more still remains to be broken up.

Genus 13. PERMOPSYLLIDIUM, n. g. (Text-figs. 25, 26.)

Tegmen broadly oval. Sc absent. R + M scarcely arched at all. R_1 straight to origin of R_{1a} , the latter an oblique branch, straight, but R_{1b} curving strongly upwards distally. Rs much shorter than in previous genus, arising closer to R_{1a} than to basal cell, strongly curved concavely to costa and hence diverging distally from M. Basal cell rather weakly formed posteriorly, about one-sixth the length of



Text-fig. 22. Clavus of a large, undetermined Homopteron, probably of the family Prosbolidae. Total length of fragment, 14.5 mm. Lettering as in Text-fig. 1.

Text-fig. 23. *Permopsylla americana* Till., family Permopsyllidae; Lower Permian of Kansas, U.S.A. Tegmen. Length 3.2 mm. Lettering as in Text-fig. 1.

Text-fig. 24. *Protopsyllidium australe*, n.g. et sp., family Permopsyllidae; Upper Permian of Warner's Bay. Tegmen. Length of fragment, 2.8 mm. Lettering as in Text-fig. 1.

Text-fig. 25. *Permopsyllidium mitchelli*, n.g. et sp., family Permopsyllidae; Upper Permian of Belmont. Tegmen. Length 3.7 mm. Lettering as in Text-fig. 1.

Text-fig. 26. *Permopsyllidium affine*, n. sp., family Permopsyllidae; Upper Permian of Belmont. Tegmen. Length 3.7 mm. Lettering as in Text-fig. 1.

Text-fig. 27. *Permothea latipennis*, n.g. et sp., family Permopsyllidae; Upper Permian of Warner's Bay. Tegmen. Length 3 mm. Lettering as in Text-fig. 1.

tegmen or a little less. M three-branched, the extra fork being on M_{1+2} . Cross-vein rm present, mcu absent. Cu_1 forked. Clavus missing, but probably no anal veins present.

Genotype, *Permopsyllidium mitchelli*, n. sp.

Horizon.—Upper Permian of Belmont, N.S.W.

The two closely allied species may be distinguished as follows:

Costa very slightly curved; M_1 curved convexly to Rs right to apex of wing *P. mitchelli*, n. sp.
 Costa strongly curved; M_1 running straight to apex of wing *P. affine*, n. sp.

24. PERMOPSYLLIDIUM MITCHELLI, n. sp. (Text-fig. 25.)

Tegmen (perfect except for loss of clavus) 3.7 mm. long; greatest breadth 1.6 mm. A pale greyish reverse impression, with apex to right, on chert of same colour. R_1 is a strongly impressed vein right to end of R_{1b} , but R_{1a} is weak distally. All the other veins except Cu_2 are slightly flattened, giving a double outline in the fossil. Cross-vein rm rather weak, falling on to M_{1+2} about its middle. M_1 curved convexly to Rs right up to apex of wing. Pterostigmatic area about four times as long as wide. The weakly formed free basal piece of Cu_1 bounding the basal cell distally is strongly bent up almost at right angles to the rest of the same vein.

Type: *Holotype tegmen*, Specimen No. 57 in Mr. Mitchell's Collection; found by him at Belmont, March 3rd, 1922.

25. PERMOPSYLLIDIUM AFFINE, n. sp. (Text-fig. 26.)

Tegmen (perfect except for loss of clavus and slight damage to apical border) 3.7 mm. long; greatest breadth 1.7 mm. A pale buff-coloured, obverse impression, with apex to right, strongly tinged with yellow apically, on a whitish chert. Closely similar to the previous species, from which it differs in the more curved costa, the distinctly shorter pterostigmatic region, R_{1a} equally strongly marked from origin to apex, cross-vein rm more strongly marked, M_1 slightly curved basally only, then running straight to apex of wing, free basal piece of Cu_1 not quite so strongly bent, Cu_{1a} somewhat more curved.

Type: *Holotype tegmen*, Specimen No. 89 in Mr. Pincombe's Collection; found by him at Belmont, Sept. 20th, 1924.

Genus 14. PERMOTHEA, n. g. (Text-fig. 27.)

Tegmen: Sc present as a free vein basally, then fused with R ; a costal veinlet close to origin of Rs may be the free end of Sc . Pterostigmatic area flatly triangular, strongly chitinized so as to form a true pterostigma. Rs arising at about one-third from base, slightly curved basally, then running straight to near apex of tegmen. Cross-vein rm present, mcu absent. M three-branched. Basal free piece of Cu_1 not much curved, meeting M at about its own length from R, so that basal cell is somewhat diamond-shaped. Cu_1 two-branched.

Genotype, *Permothea latipennis*, n. sp.

Horizon.—Upper Permian of Warner's Bay, N.S.W.

26. PERMOTHEA LATIPENNIS, n. sp. (Text-fig. 27.)

Tegmen 3 mm. long; greatest breadth 1.5 mm. A rather dark greyish impression on a chert of almost as dark a colour; obverse, with apex to right. Clavus missing, costal margin irregularly broken away in places, and a faint crack crossing the wing in the middle transversely. The missing costa is restored

by a dotted line in Text-fig. 27, as is also the clavus. Cross-vein *rm* is faintly marked and falls on to origin of M_2 ; this latter vein and also Cu_{1b} are posterior branches of M_{1+2} and Cu_1 respectively, the former running without a break to end of M_1 , the latter similarly to end of Cu_{1a} . Main stem of M straight, that of Cu_1 slightly curved.

Type: *Holotype tegmen*, Specimen No. 85a in Mr. Mitchell's Collection; found by him at Warner's Bay in 1923.

Family Lophioneuridae.

Sc present or absent. R_1 simple, with pterostigma linear or absent. Rs forked distally. M and Cu_1 both with two branches only. Tegmen rather narrowly oval, with clavus reduced to a very narrow area below the somewhat shortened Cu_2 .

Genus 15. LOPHIONEURA Till.

Tillyard, 1922a, p. 417, 418, Text-fig. 3.

Characters as for the family.

Genotype, *Lophionaura ustulata* Till.

Horizon.—Upper Permian of Merewether Beach and Belmont, N.S.W.

27. LOPHIONEURA USTULATA Till.

A beautifully preserved tegmen, 5.7 mm. long by 1.9 mm. wide, found by Mr. Mitchell in a piece of burnt shale from the railway embankment at Merewether Beach in 1921. Sc is complete, widely separated from R_1 , ending up before half-way along costa. R_1 ends in a thickened linear pterostigma which extends beyond the end of R_{2+3} almost to apex of wing (end of R_{4+5}). Cu_1 , M and Rs arise separately from $R+M$ near base, one after another, and there is no basal cell present. Apical fork of M large, that of Cu_1 small, with Cu_{1a} much arched, thus being closely similar to the *areola postica* of Copeognatha. Type in Mr. Mitchell's Collection.

28. (?) LOPHIONEURA CONJUNCTA, n. sp.

Tegmen 4.4 mm. long; greatest breadth 1.7 mm. The impression is a reverse, with apex to left, on a medium grey chert; clavus missing, and an oblique crack running across wing. Venation somewhat obscure, the courses of R_1 and Rs in particular not at all clear. Costa exceptionally thick from base up to pterostigmatic area. Differs also from *L. ustulata* Till. in its smaller size, much shorter apical fork of M , presence of *rm*, and in M and Cu_1 coming off by a common stalk from $R+M$. Only provisionally placed in this genus until a better impression can be obtained, when it will probably be found that a new genus is required for it.

Type: *Holotype tegmen*, Specimen No. 79 in Mr. Pincombe's Collection; found by him at Belmont, August, 1924.

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EXPLANATION OF PLATE I.

- Fig. 1.—*Orthoscytina mitchelli*, n.g. et sp. Holotype tegmen; length 10 mm. Family Scytinopteridae.
- Fig. 2.—*Permoglyphis belmontensis*, n.g. et sp. Holotype tegmen; length 9.4 mm. Family Prosbolidae.
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